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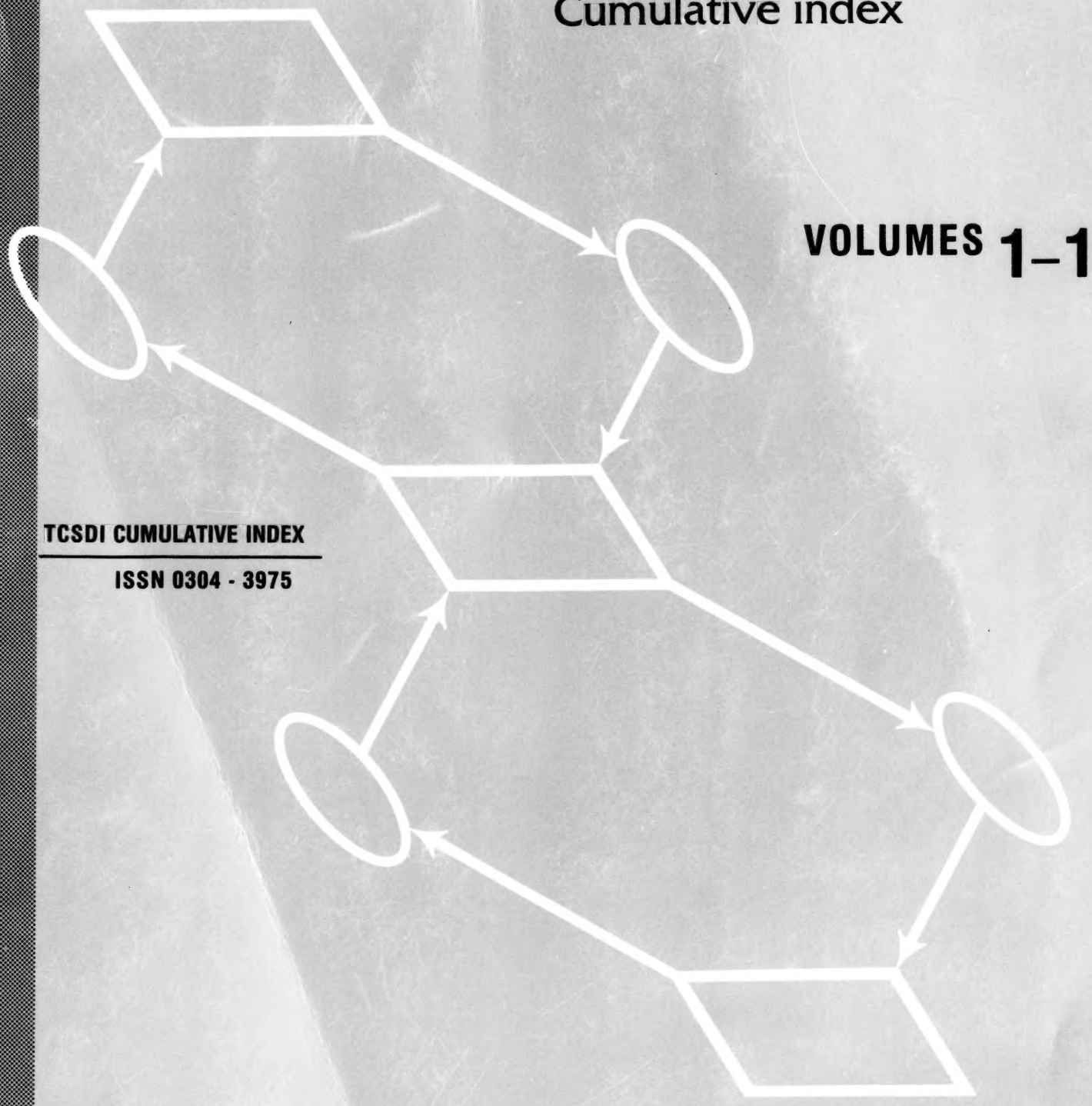

VOLUMES 1–100

TCSDI CUMULATIVE INDEX

ISSN 0304 - 3975

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Theoretical Computer Science (ISSN 0304-3975) is published in 14 volumes (28 issues) per year. The subscription price for 1992 (Volumes 90–103) is Dfl. 3220.00 + Dfl. 434.00 p.h. = Dfl. 3654.00. (US$ 1995.00). (Combined subscription: Theoretical Computer Science *and* Science of Computer Programming (Vols. 18–19): Dfl. 3360.00 + Dfl. 496.00 p.h. = Dfl. 3856.00 (US$ 2105.00).) The Dutch guilder price is definitive. The US dollar price is subject to exchange-rate fluctuations and is given only as a guide. Subscriptions are accepted on a prepaid basis only, unless different terms have been previously agreed upon. Personal subscription rates and conditions, if applicable, are available upon request from the Publisher. Subscription orders can be entered only by calendar year (Jan.–Dec.) and should be sent to Elsevier Science Publishers, Journal Department, P.O. Box 211, 1000 AE Amsterdam, The Netherlands, telephone 31.20.5803642, fax 31.20.5803598, or to your subscription agent. Postage and handling charges include surface delivery except to the following countries where air delivery via SAL (Surface Air Lifted) mail is ensured: Argentina, Australia, Brazil, Canada, Hong Kong, India, Israel, Malaysia, Mexico, New Zealand, Pakistan, PR China, Singapore, South Africa, South Korea, Taiwan, Thailand, USA. For Japan air delivery (SAL) requires 25% additional charge of the normal postage and handling charge. For all other countries airmail rates are available upon request. Claims for missing issues must be made within three months of our publication (mailing) date, otherwise such claims cannot be honoured free of charge.

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This journal is printed on acid-free paper.

Printed in The Netherlands

0304-3975/92/$05.00

Theoretical Computer Science

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Cumulative Index Volumes 1–100 – 1992

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ACM Computing Reviews
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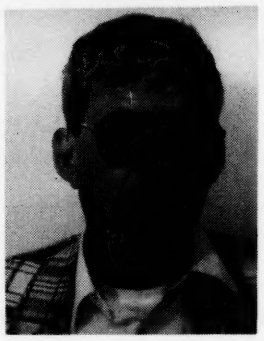

Maurice Nivat was born in 1937. He studied at the Ecole Normale Supérieure in Paris and received his Ph.D. in 1967. In 1965 he was appointed Professor of computer science in Grenoble and in 1967 he moved to Rennes. Since 1969 he has been working at the Université de Paris VII. Professor Nivat has been a consultant of Thomson CFS Research Laboratories, Project-head of the Institut National de la Recherche en Informatique et Automatique (INRIA), and head of the Laboratoire d'Informatique Théorique et Programmation (LITP). He is a former President of the European Association of Theoretical Computer Science (EATCS). In 1983 he was elected corresponding member of the French Academy of Sciences.

He has been the Editor-in-Chief of *Theoretical Computer Science* since its foundation in 1975. Under his guidance – together with other "founding fathers" such as Meyer, Paterson and Salomaa – *TCS* has grown from 360 pages to 5400 pages per annum. The first fifty volumes were published in the period 1975–1987. This centennial volume, however, was reached within 17 years.

His research interests include: theory of languages and automata, infinite words and trees, algebraic methods in semantics, synchronization of concurrent processes, and tiling problems.

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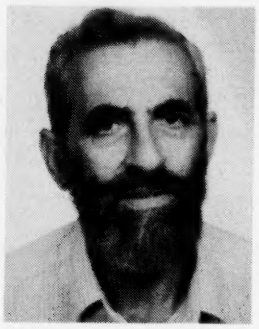
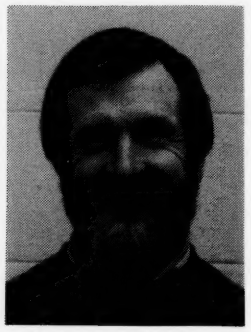


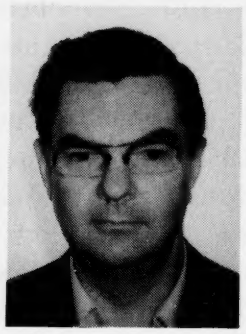
Aviezri Fraenkel is a Professor in the Department of Applied Mathematics and Computer Science at the Weizmann Institute of Science, Rehovot, Israel. He received his B.Sc., E.E. Diploma and M.Sc. from the Technion–Israel Institute of Technology in electrical engineering, and a Ph.D. in mathematics from UCLA. Dr. Fraenkel has founded the Responsa Storage and Retrieval Project, which he directed for its first ten years. He has published some 120 research papers in his areas of interest, which currently include combinatorial number theory, combinatorial games, analysis and complexity of combinatorial algorithms; the notion of complexity in mathematical, physical an biological systems; robust encoding and compression of data, and information storage and retrieval.



Michael S. Paterson was born in London in 1942. He studied at the University of Cambridge and received his B.A. in mathematics in 1964 and his Ph.D. in mathematics in 1968, both from the University of Cambridge. He held a position as Instructor (1968–69) and Assistant Professor (1969–71) at the Mathematics Department of MIT. In 1971 he moved to the Department of Computer Science of the University of Warwick in Coventry, where he has been a Professor since 1979. From 1985 to 1990 he was a SERC Information Technology Senior Fellow. Professor Paterson has been a council member and is a Past President of the European Association of Computer Science (EATCS). He is on the editorial board of various international journals. His research interests include: complexity theory and analysis of algorithms.

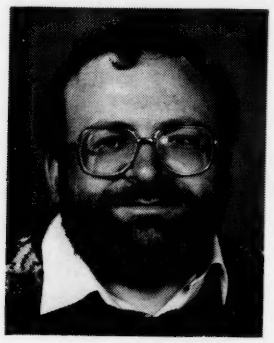
Martin Wirsing received his Ph.D. in Logic (1975) from the University of Munich and his Habilitation in theoretical computer science (1984) from the Technical University of Munich. From 1985 to 1992 he taught computer science as a Full Professor at the University of Passau. He has been Chairman (1986–88) and Vice-Chairman (1988–90) of the Faculty of Mathematics and Computer Science and one of the directors of the Bavarian Center for Knowlegde-based Systems (1990–92). Since 1992 he is a Full Professor at the University of Munich. Prof. Dr. Wirsing has published more than 100 scientific papers in the areas of mathematical logic, semantics, program development and formal specification.

Advisory Editor

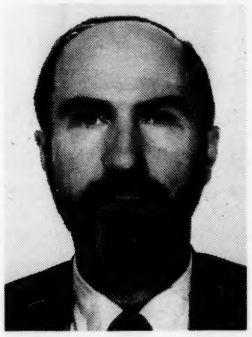


M. Sintzoff received his Licence en Sciences Mathématiques from the University of Louvain in 1962. In 1962–64 he was assistant lecturer at the University of Lubumbashi, Zaire. Between 1964 and 1982 he was a member of the Philips Research Laboratory in Brussels. He was an invited professor at the Universities of Brussels (1971–74), Louvain (1972–82), Alberta, Canada (1972–73), Paris VI (1973–75) and a researcher at CNRS, Nancy (1977–78). Since 1982, he has been a Professor at the Université de Louvain. His fields of interest include: programming methods, languages and calculi; parallel programs and transition systems; and formal systems.

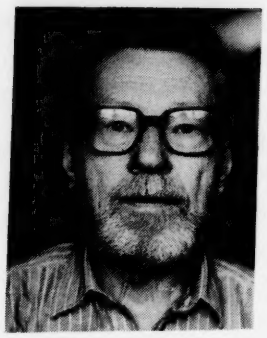
Editorial Board



Samson Abramsky graduated from Cambridge University with an M.A. in philosophy and a Diploma in computer science in 1976. He then worked for two years in industry on operating system development, returning to university at Queen Mary College, University of London, in 1978 to do a Ph.D. In 1983, he moved to Imperial College, where he is currently a Professor of computing science and head of the Theory and Formal Methods Section in the Department of Computing. His research interests include: semantics of programming languages, applications of logic, category theory and topology in computer science, integration of programming paradigms, semantics-based program analysis and linear logic.

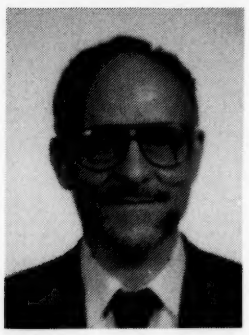


Giorgio Ausiello is a Full Professor of computer science at the Department of Computer and Systems Science of the University of Rome "La Sapienza" since 1980. He graduated in physics in 1966 and spent two years at the University of California in Berkeley as a postdoctoral visitor. He wrote more than seventy scientific papers and books and is editor of various international journals. He organized several international conferences and workshops. He has been one of the founders of the European Association of Theoretical Computer Science in 1972. Since 1988 he is a member of the Scientific Council of the Committee for Engineering Sciences of the Italian National Research Council. His main research interests are: computational complexity, analysis and design of algorithms, combinatorial optimization and database theory.



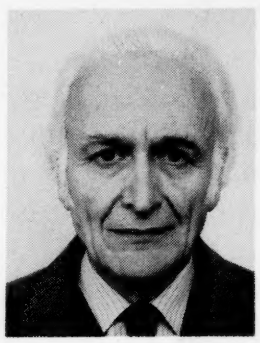
Jiří Bečvář was born in Prague in 1926. During 1945–49 he studied mathematics at the Charles University in Prague. Between 1951 and 1954 he had a research scholarship in the Mathematical Institute of the Czechoslovak Academy of Sciences (MÚ ČSAV). In 1954 he became a member of the Department of Mathematics at the Institute of Machine and Textile Engineering in Liberec. In 1964 he obtained his Habilitation in automata theory. Since 1968 he has been a research worker in the MÚ ČSAV in Prague. Since 1959 he participated in organizing a seminar there on algorithmic structures (originally on cybernetics and automata theory). For several years he participated in the organization of the international symposium Mathematical Foundations of Computer Science. His fields of interest include: mathematical logic and cognitive aspects of (computer) science, complexity theory, identification and approximation of structures and processes, semantics of inexact constructs, and foundation of algorithmic and stochastic structures.

Claude Berge, Professor of mathematics, has been the Director of Research at CNRS (National Centre for Scientific Research) since 1964. During 1964–68 he was (elected) Director of the International Computation Centre (ICC) in Rome. He was a Visiting Professor at Penn. State University in 1969 and at New York University in 1985. He is honorary editor and advisory editor of various international journals. He was awarded the Prix Scientifique U.A.P. (1988) and the Euro Gold Medal (1989). He published various scientific books and he is a member of OULIPO, a group of writers founded by Raymond Queneau (with whom he published several books and poems). His current research interests include: combinatorial optimization, game theory and graph theory.

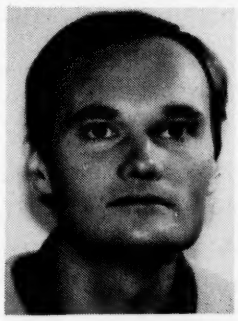


Elwyn Berlekamp received the B.S., M.S. and Ph.D. degrees from MIT in 1962 and 1964. At various times since then he was a member of the Mathematics Research Group at AT&T Bell Laboratories, a professor of mathematics, electrical engineering and computer science at the University of California at Berkeley, and founder and president of Kodak Berkeley Research. He is currently very interested in the application of combinatorial game theory to Go, the Asian board game. His other interests have included algebraic coding theory and its applications, architecture and design of special-purpose high-performance electronic systems, and technical models to forecast stock and commodity prices.

Hans Berliner received his Ph.D. in computer science from Carnegie Mellon University (CMU) in 1975. He is presently Principal Research Computer Scientist at CMU. His nonacademic achievements include having been world correspondence chess champion (1968–72) and having been one of America's top chess players during the 1950s and 60s. In 1979, his computer program BKG 9.8 defeated the reigning world backgammon champion by a score of 7–1 in a special challenge match. This was the first time a computer program had beaten a world champion in a recognized intellectual activity. Dr. Berliner has headed the development of the chess-computer program Hitech which was the best chess computer from 1985 to 1988. Hitech was the first computer to achieve Senior Master status, and to beat a Grandmaster in a set match. Dr. Berliner is a fellow of the American Association for Artificial Intelligence and a member of the US Chess Hall of Fame. His interests are principally in artificial intelligence and are usually associated with game environments.

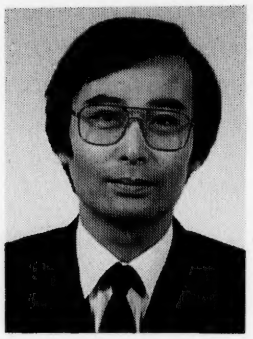


Corrado Böhm was born in 1923. He received his Diploma of electrical engineering at the EPUL in Lausanne in 1946 and his Ph.D. in mathematics at the ETH in Zürich in 1952. His Ph.D. thesis, directed by Bernays and Stiefel, contained the description of a compiler (four years before Fortran) which was the first compiler written in its own language. He was a researcher at CNR in Rome, and an Associate Professor in Pisa and Rome (1954–67). In 1968 he became a Full Professor of numerical analysis in Modena (1968) and the first Full Professor of computer science in Turin (1968). In 1974 he taught programming techniques at the University of Rome "La Sapienza" and today he teaches semantics of programming languages at the Dipartimento di Scienze dell'Informazione of the same university. He has done reseach in the following areas: results on Turing and von Neumann machines, theoretical basis of structured programming (Böhm–Jacopini Theorem), discriminability of terms in lambda calculus, reduction CUCH (CUrry and CHurch) machines for lambda calculus and combinatory algebras, untyped functional and automatic programming.

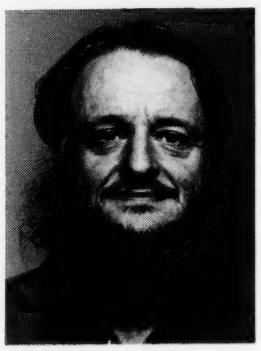


Jean-Daniel Boissonnat graduated from the Ecole Supérieure d'Electricité in 1976. He obtained his Ph.D. from Rennes University in 1979. He joined INRIA Rocquencourt in 1980 as a Chargé de Recherche and became Directeur de Recherche in 1984. Since 1986, he has leaded the PRISME Project at INRIA Sophia-Antipolis. He has published papers on automatic control, robotics and computational geometry. He has received the IBM Award in computer science in 1987 and the FIAT/French Academy of Science Award in 1989 (shared with other INRIA researchers). He is currently on the editorial board of two French journals and of six international journals devoted to algorithms and computational geometry.

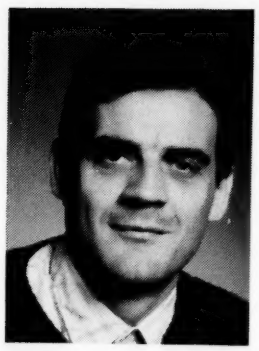
Ronald V. Book is a Professor at the University of California, Santa Barbara. He received his Ph.D. from Harvard University in 1969, and has been at UC Santa Barbara since 1976. Professor Book has had the honour of supervising the work of a number of talented young computer scientists and mathematicians from various countries. Initially he worked in formal language theory, which has led, via string-rewriting, to a continuing interest in rewriting systems and computational logic. Today his primary research interest lies in the area of structural complexity theory.



Kyung-Yong Chwa received the B.S. degree in electrical engineering from Seoul National University in 1971, and the M.S. and Ph.D. degrees in electrical engineering and computer science form Northwestern University, Evanston, IL, in 1977 and 1980, respectively. Since 1980 he has been with the Department of Computer Science at KAIST (Korea Advanced Institute of Science and Technology), where he is currently a Professor. From March 1985 to July 1986 he worked at IBM Thomas J. Watson Research Centre, Yorktown Heights, as a visiting scientist. He is also the vice-president of the Korea Information Science Society. Professor Chwa's research interests are in the areas of applied graph theory, design and analysis of computer algorithms, and computational geometry.

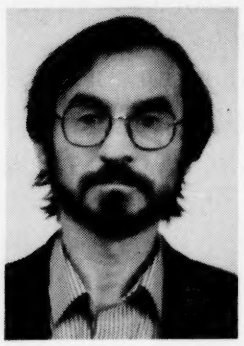


John Conway was born in Liverpool, England in 1937. He is a Fellow of Gonville and Caius College and a former Fellow of Sidney Sussex College, Cambridge, and is Reader in pure mathematics at the University of Cambridge. He has held visiting professorships at several universities and has made original contributions to many branches of mathematics, notably transfinite mathematics, the theory of knots, many-dimensional geometry and the theory of symmetry (group theory). He has published the books *Regular Algebras and Finite Machines* and *On Numbers and Games*. In 1983 he was made a fellow of the Royal Society. Since 1985, he has been John von Neumann Professor of Mathematics at Princeton University.

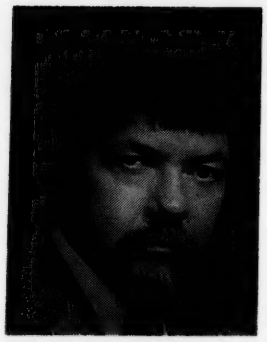


Pierre-Louis Curien is graduated from the Ecole Normale Supérieure. He received his Doctorat d'Etat in computer science in 1983. In 1990, he was awarded the IBM France Award in computer science. His research interests cover the syntactic and semantic aspects of programming languages, with a particular interest in lambda calculus, operational semantics and domain theory. He designed, with G. Cousineau and M. Mauny as coworkers, an abstract machine – the categorical abstract machine – which served as a basis for the implementation of the functional language CAML.

Jaco de Bakker obtained his Ph.D. from the University of Amsterdam in 1967 (dissertation *Formal Definition of Programming Languages*, promotor A. van Wijngaarden). He has been employed by the CWI (Centre for Mathematics and Computer Science) since 1964, currently as head of its Department of Software Technology. He has participated in Dana Scott's development of the fixed point theory for recursion in 1969, and has worked on sequential semantics and program correctness in the seventies. Since 1981, he has directed the Amsterdam Concurrency Group, which has investigated semantics for parallel languages, with special emphasis on (ESPRIT-supported) studies of logic and object-oriented programming. His current interests are semantics, concurrency and programming logic.

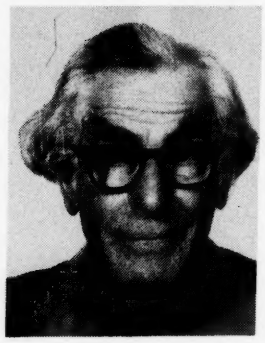


Josep Díaz received his Ph.D. (Doctor en Ciencias Fisicas) from the Universidad Literaria de Valencia in 1981. In 1976 he was a research assistant at the Computer Science Institute of the University of California in Riverside. From 1978 he was an Instructor at Riverside College. In 1978 he became a Profesor Contratado at the Faculty of Informatics of the Universitat Politècnica Catalunya (UPC) in Barcelona. Since 1984 he has been Catedratico Numerario de Informatica Teorica at UPC and since 1988 head of the department. He has written and co-authored several books and papers and is responsible for the Barcelona team participating in BRA ESPRIT-II "ALCOM".

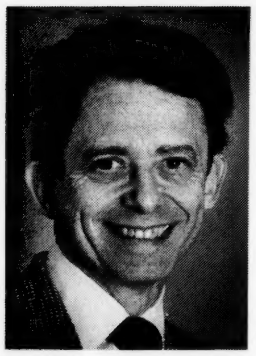


Peter J. Freyd was born in 1936. After early positions at Brown University, Princeton, and Columbia, he has been based at the University of Pennsylvania since 1962 where he is presently a Professor of mathematics and of computer science. He has been a visiting faculty member at the University of Chicago, Pahlavi University (Iran), ETH (Zurich), University of New South Wales (Australia), University of Mexico, Cambridge University, University of Louvain, University of Sydney, University of Milan, Carnegie Mellon University and University of Parma. He is best known for his work in category theory and its applications. In theoretical computer science he has investigated categorial semantics for polymorphism and recursive types.

Koichi Furukawa received his B.E. degree in instrumentation physics, the M.E. degree in mathematical engineering and the D.Eng. degree in information engineering from the University of Tokyo in 1965, 1967 and 1980, respectively. He joined the Electrotechnical Laboratory in 1967, where he has been involved in developing ETSS, ETL's time-sharing system. In 1975–76, he was a visiting research fellow at SRI and he was engaged in the research of deductive databases. In 1979–82, he was involved in planning the Fifth Generation Computer Project. In 1982, he moved to ICOT and since then he has been working on logic programming. His current research interests are artificial intelligence, machine learning, logic programming and programming methodology. Dr. Furukawa is currently the Deputy Director of the ICOT Research Center.

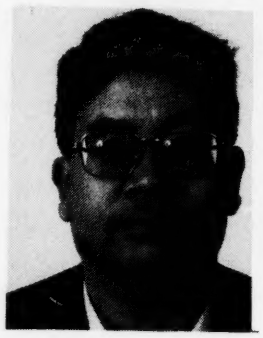


Richard K. Guy has taught mathematics in England, Singapore, India and Canada. He has served as a Governor of the Mathematical Association of America and on the Council of the American Mathematical Society. He edited the second series of *Reviews in Number Theory*, wrote *Unsolved Problems in Number Theory* and *Fair Game*, and was co-author (with Hallard Croft and Ken Falconer) of *Unsolved Problems in Geometry* and (with Elwyn Berlekamp and John Conway) of *Winning Ways for your Mathematical Plays*. He has edited the Unsolved Problems section of *American Mathematical Monthly* since 1970. In 1991 he was awarded an honorary degree by the University of Calgary.



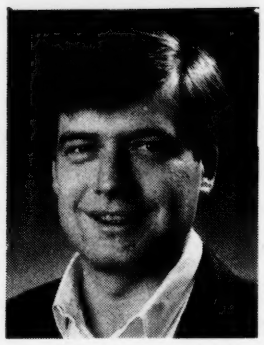
Michael A. Harrison is a Professor of computer science at the University of California at Berkeley. He received his Ph.D. from the University of Michigan in Ann Arbor and immediately joined the University of California at Berkeley. He has been a visiting professor and spent sabbaticals at MIT, Stanford University, the University of Frankfurt and the Hebrew University in Jerusalem. He has held a Guggenheim Fellowship, been a National Lecturer for the Association of Computing Machinery, and a Distinguished Visitor of the IEEE Computer Society. He has been Vice-President of the ACM and a Director and Trustee of a number of organizations. He has written five books and well over one hundred technical publications. He is a founder and Chairman of the Board of Gain Technology Incorporated. His research interests are user interfaces, hypermedia systems, algorithms and languages.

Oscar H. Ibarra received the B.S. degree in electrical engineering from the University of the Philippines in 1962 and the M.S. and Ph.D. degrees, also in electrical engineering from the University of California at Berkeley in 1965 and 1967, respectively. From 1967 to 1969 he was an Assistant Professor of electrical engineering and computer sciences at the University of Califorina, Berkeley. He joined the University of Minnesota in 1969 where he helped establish the university's Computer Science Department. When the Minnesota Supercomputer Institute was created, he was elected one of its first fellows. He joined the University of California at Santa Barbara in 1990 where he is a Professor of computer science. Dr. Ibarra was awarded a Guggenheim Fellowship in 1984 for his work in systolic systems. His primary research interests are in the design and analysis of algorithms, the theory of computation, computational complexity, and parallel computing.



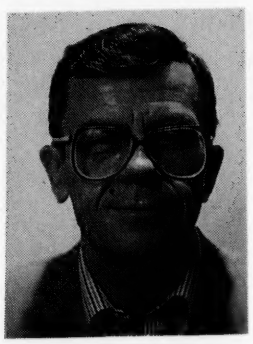
Masami Ito received his B.Sc. from Kyoto University in 1965 and his M.Sc. also from Kyoto Universtiy in 1967. In 1979, he received his Ph.D. from Tohoku University in Sendai. Since 1979 he has been Professor at the Kyoto Sangyo University in Kyoto. His fields of interest include: theory of semigroups, algebraic theory of automata and codes, and theory of formal languages.

Takayasu Ito was born in Osaka, Japan, in 1940 and he graduated from Kyoto University in 1962. He worked on program schemata, regular tree expressions and theoretical aspects of pattern recognition and artificial intelligence. Since 1978 he is Professor of computer science at Tohoku University at Sendai, Japan. He is currently interested in formal models of concurrency and parallel symbolic computing.

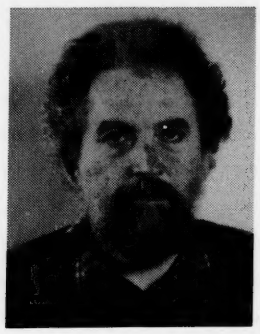


Gerhard Jäger studied mathematics and philosophy at the University of Munich. In 1979 he received his Ph.D. and in 1985 his Habilitation in mathematics from the University of Munich. Between 1979 and 1984 he held research and teaching positions at the Universities of Munich, Oxford and Stanford, and from 1984 until 1988 he worked at the ETH Zurich. Since 1988 he is a Professor of theoretical computer science at the University of Berne, Switzerland. His fields of interest are: theoretical computer science, mathematical logic, computer science logic, logic and computation, proof theory, deductive systems, logic programming, type theory, subsystems of analysis and set theory, lambda calculus, knowlegde representation and symbolic computation.

Paris C. Kanellakis is a Professor of computer science at Brown University. He received a Ph.D. in computer science from MIT in 1982. His primary research interests are in applications of logic to computer science, in particular: the theory of databases (relational, deductive and object-oriented), logic programming and the problem of term unification, programming languages and the problem of type inference. He has also contributed to the theory of distributed computing and to combinatorial optimization. He has published many articles on these subjects and is the author of one of the chapters of the *Handbook of Theoretical Computer Science* and he has edited a number of books on databases.

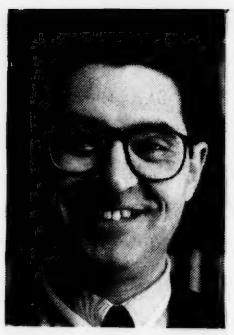


Vadim Kotov obtained his M.Sc. from the Institute of Physics Engineering in Moscow in 1963, his Ph.D. from the Novosibirsk Computing Center of the USSR Academy of Sciences in 1971 where he worked from 1963 to 1990. Since 1990 he is Director of the Institute of Informatics Systems in Novosibirsk, Russia. He is a member of the Russian Academy of Sciences. His main research interest is in the theory of concurrency and its application to computer architectures and languages. He studied parallel program schemata and automatic parallelization of sequential programs. Then, he worked on compositional algebras for Petri nets and related concurrency models. Recently, he has been studying structure $\leftrightarrow$ behaviour interrelations in concurrent systems. He has been head of several projects resulting in experimental concurrent languages and computer systems.



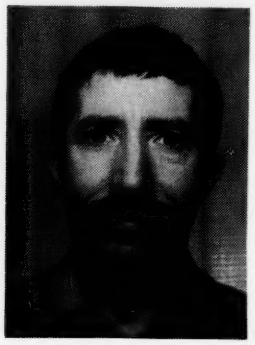
Giorgio Levi obtained his Laurea in electrical engineering from the University of Padova in 1966 and the Libera Docenza in 1971. He was Research Associate at the Istituto di Elaborazione della Informazione, National Research Council, Pisa, from 1966 to 1981. He became a Full Professor of computer science at the Dipartimento di Informatica of the University of Pisa in November 1981. His research interests include programming languages and artificial intelligence. He is currently active in the area of logic programming. He was chairman of several international conferences and is member of the Executive Committee of the Association of Logic Programming. He is particularly interested in the following fields: semantics of logic programs, constraint logic programming, concurrent logic programming and semantics-based program analysis.

Zohar Manna is a Professor of computer science at Stanford University and at the Weizmann Institute in Israel. He received his B.S. and M.S. degrees in mathematics from the Technion in Israel and his Ph.D. degree in computer science from Carnegie Mellon University. He is author and co-author of various textbooks. Professor Manna is also an associate editor of a number of international journals. His research interests include automated deduction, logic of programs, concurrent and real-time systems, and the verification and synthesis of programs.

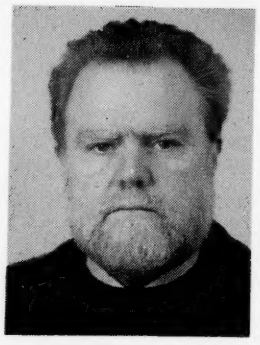


Albert R. Meyer[a] is the Hitachi America Professor of Engineering at the MIT Department of Electrical Engineering and Computer Science. He is a founding editor of *TCS* who has contributed to many areas of theoretical computer science – automata, algorithms, complexity theory and program semantics – during a twenty-five year career. He is best known for having discovered the first examples of provably complex – nonpolynomial-time – decision problems, as well as such fundamental concepts of complexity theory as polynomial-time hierarchy. His current interests focus on logic semantics of programs, concurrent process theory, and type theory and polymorphism.

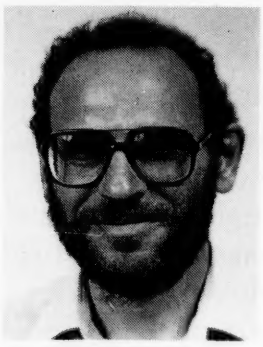
[a]Photo: Donna Coveney / MIT.



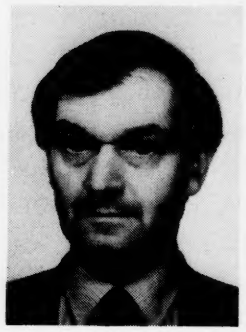
Isi Mitrani received his Ph.D. degree in computer science in 1973 from the University of Newcastle, having previously studied mathematics at the Universities of Sofia and Moscow, and operations research at the Technion, Haifa, Israel. Since 1970 he has held various teaching positions at the Computing Laboratory, University of Newcastle, where he is now a Professor. His publications include five books, two book chapters and over sixty articles. His research interests are in the fields of stochastic processes, probabilistic modelling and performance evaluation of computer and communication systems.



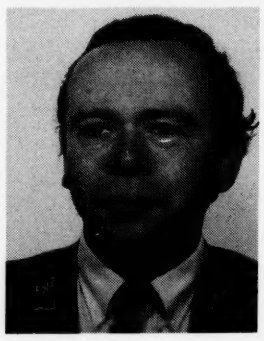
Ugo Montanari is a Full Professor of computer science at the Dipartimento di Informatica, University of Pisa, since 1976. He graduated in electrical engineering from the Politecnico of Milan in 1966 and had a position of researcher with the Istituto di Elaborazione della Informazione in Pisa in the period from 1968 to 1976. He also visited (for a total period of approximately thirty months) several well-known American and European universities and research centers. He is a member of Academia Europæa. He wrote pioneering papers in the areas of picture recognition, graphics, graph grammars, heuristically guided search, networks of constraints, algebraic data types, logic unification and true concurrency. His present interests include the semantics of concurrency (also higher order), certain aspects of (concurrent) software specification, concurrent constraint programming and the algebraic treatment of structured transisition systems.



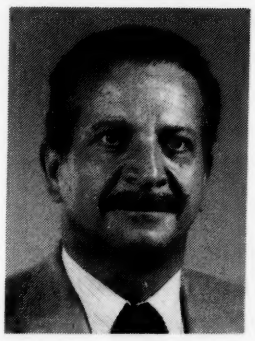
Victor Y. Pan received his M.S. and Ph.D. degrees in mathematics from Moscow University in 1961 and 1964, respectively. He worked at the Economics Institute of the Soviet Academy of Science, Moscow; IBM Research Center, Yorktown Heights, NY; SUNY Albany, NY; Stanford University; Institute for Advanced Study, Princeton, NJ; University of Pisa; Columbia University, New York; International Computer Science Institute, Berkeley, CA. He was a consultant for the General Electric Research and Development Center, Schenectady, NY, and for the AT&T Bell Laboratories, Murray Hill, NJ. Currently he is a Professor of mathematics and computer science at Lehman College, CUNY, Bronx, NY, and teaches also at the Graduate Center of CUNY, New York. His research interests include: analysis and synthesis of algebraic, numerical and combinatorial algorithms, computational complexity theory, parallel computation, randomized algorithms, operations research and optimization, and computations in graphs.



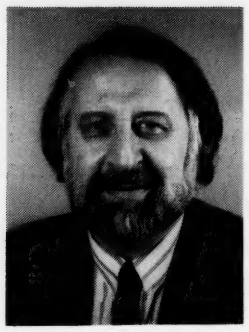
Roger Penrose was born in Colchester, Essex, UK, in 1931. He received his B.Sc. in mathematics from the University College London in 1952, and his Ph.D. from St. John's College in Cambridge. He held various positions in the UK and the US before being appointed Rouse Ball Professor of Mathematics, Oxford Fellow of Wadham College, Oxford. Since 1987 he is also Distinguished Professor of Physics (and Mathematics) of Syracuse University. Numerous are the conferences and congresses he has attended, the editorial boards he is on and the scientific papers and books he has written and co-authored. He was awarded several prizes (two of which shared with S.W. Hawking). His chief research interests are broadly: mathematical physics (also foundation and philosophy of physics), and more specifically: general relativity; twistor theory; the impact of general relativity on the structure of quantum theory; space–time singularities, black holes and cosmology; quasi-crystals and aperiodic tiles; possible nonalgorithmic action in brain function.



Dominique Perrin was born in Paris in 1946. He graduated from the Ecole Polytechnique in 1968. In 1975, he received his Doctorat at the Université de Paris VII with M.P. Schützenberger. He held positions at the Centre National de la Recherche Scientifique (CNRS) (1969–77), the Universidad de Chile (1972) and the Université de Rouen (1977–83), the Université de Paris VII (since 1983) and the Ecole Polytechnique (since 1989). In 1985 he was appointed Director of LITP. His research interests include: theory of automata, combinatorics on words, enumerative combinatorics, noncommutative algebra, algorithms on words, computational linguistics, permutation groups and formal logic.

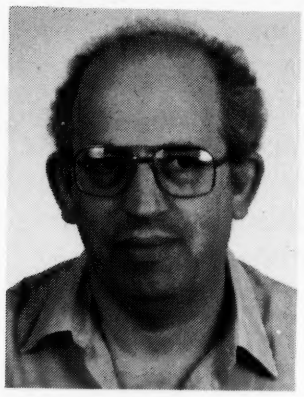


Franco F. Preparata is the An Wang Professor of Computer Science at Brown University since January 1991. Formerly he was a Professor of electrical engineering and of computer science at the University of Illinois at Urbana-Champaign. He received the Dr.Ing. and the Libera Docenza from the Italian University System. He began his research activity in switching theory and coding theory, and gradually his research interest evolved towards the analysis and design of algorithms. He has published three textbooks and nearly 150 research articles. A Fellow of the IEEE, he is on the editorial board of several professional journals. His research interests include: computational geometry, parallel computation, and numerical and combinatorial algorithms.



Grzegorz Rozenberg is a Professor at the Department of Computer Science of the University of Leiden, The Netherlands, and an Adjoint Professor at the Department of Computer Science of the University of Colorado at Boulder. He received his Ph.D. in 1968 and hold academic positions at the Institute of Mathematics of the Polish Academy of Science in Warsaw, the Department of Mathematics of the University of Utrecht, the Department of Mathematics of the University of Antwerp, and the Department of Computer Science of the State University of New York in Buffalo, NY. Currently he is the President of the European Association of Theoretical Computer Science (EATCS) and the Chairman of the Steering Committee of the International Conference on Application and Theory of Petri Nets. He is also an editor of a number of international journals and book series. He has authored two books and 250 scientific publications, he also edited about fifteen books. His research interests include formal languages, automata theory, theory of graph transformations, theory of concurrent systems (in particular Petri nets), developmental systems and languages, and mathematical structures for computer science (in particular the theory of 2-structures).

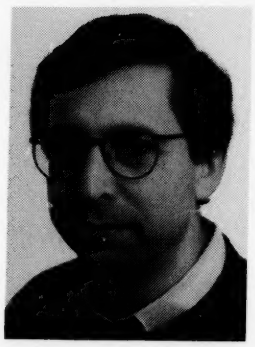
Arto Salomaa is a Research Professor at the Academy of Finland and the head of the Academy's research project concerning mathematical structures in computer science. He received his Ph.D. in 1960 and has been Professor of mathematics at the University of Turku since 1965. Dr. Salomaa was Visiting Professor of computer science in London, Canada; Aarhus, Denmark; and Waterloo, Canada, and has made numerous short visits to universities in Europe, Asia and North America. He was the EATCS President from 1979 until 1985 and is currently the Editor-in-Chief of the EATCS Monograph series. He has authored 300 scientific publications including eight books, some of which have also appeared in French, German, Japanese, Romanian, Russian and Vietnamese translations. Dr. Salomaa's research interests are in formal languages, developmental languages, automata theory, formal power series, cryptography and mathematical logic.



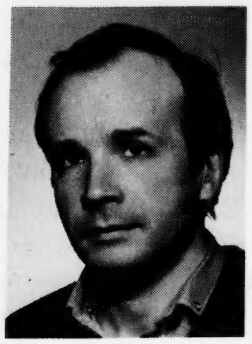
Imre Simon received an electrical engineering degree from the University of São Paulo, Brasil, in 1966 and a Ph.D. in computer science from the University of Waterloo in 1972. He is a Professor and Head of the Computer Science Department of the University of São Paulo. He is a member of the editorial boards of several international journals. He is the 1989 recipient of the French U.A.P. Prize in Informatics. His main field of interest is the theory of finite automata, ranging from pseudo-varieties of semigroups to combinatorial algorithms on words.

Rani Siromoney, born in 1929, is Professor Emiritus of the Department of Mathematics of the Madras Christian College, Tambaram, Madras, India. Her undergraduate, graduate and Ph.D. were from Madras University. She received a masters degree from Columbia University as a Fulbright Smith-Mundt scholar and was a consultant at the University of Maryland. She has a strong and active research group working with her. She is collaborating with French, Japanese and US researchers on certain projects in theoretical computer science. Professor Siromoney is the recipient of awards such as "Distinguished Author", "Best Teacher" and "Outstanding Woman Professional". Her areas of interest are formal grammars and automata, picture and graph languages, infinite words, rewriting systems and applications to cryptography and molecular biology.

Masako H. Takahashi is an Associate Professor at the Department of Information Science of the Tokyo Institute of Technology. She received her Ph.D. from the University of Pennsylvania in 1972. She published papers on tree automata (and their application to generalized parenthesis languages), automata on infinite objects and lambda calculus. She is author and co-author of two books in Japanese. Her fields of interest include: lambda calculus, type theory and logical foundations of programming.

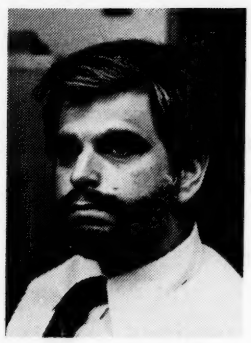


Wolfgang Thomas, born in 1947, studied mathematics at the Universities of Freiburg and Bristol, specializing in mathematical logic. In Freiburg he obtained the Doctorate (1975) and Habilitation (1980), at that time working on decidability of theories of arithmetic. In 1982 he became Associate Professor at the University of Kiel. His research is mainly concerned with connections between automata theory and logic, as well as applications to classical logic, formal language theory, complexity theory, and the specification and verification of programs. This includes the study of automata over (finite and infinite) words, trees, partial orders and graphs.

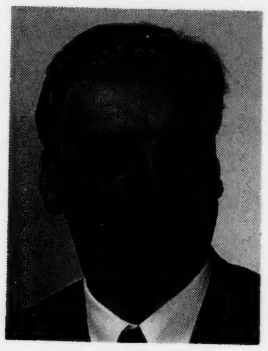


Jerzy Tiuryn graduated from Warsaw University in 1974. He received his Ph.D. – Prof. Helena Rasiowa was the thesis supervisor – from Warsaw University in 1975, and in 1982 he received his Habilitation in mathematics and computer science. Since 1974 he has been working at the Department of Mathematics, Informatics and Mechanics of Warsaw University. During the period 1974–91 he worked at the Institute of Mathematics, and in 1991 he moved to the Institute of Informatics where he is a Professor and Associate Director. In 1978–79 he visited RWTH Aachen as a Visiting Scientist. In 1981 he was a Visiting Scientist of the Laboratory of Computer Science of MIT and Visiting Associate Professor at Boston University. He spent 1984–85 and 1988–89 at Washington State University in Pullman as a Visiting Professor. His fields of interest include: logics of programs (verification, expressive power, axiomatization); lambda calculus, type theory and constructive mathematics; finite model theory; and complexity issues arising in logic and type theory.

Satish K. Tripathi is a Professor and the Chairman of the Department of Computer Science at the University of Maryland, College Park, MD. Dr. Tripathi received his Ph.D. in computer science from the University of Toronto. He has been at the faculty of the University of Maryland since 1978. During the 1984–85 academic year he was Visiting Professor at the Université de Paris-Sud and the University of Erlangen–Nürnberg. For the last fifteen years he has been actively involved in research related to performance evaluation, architectures, networks and fault tolerance.



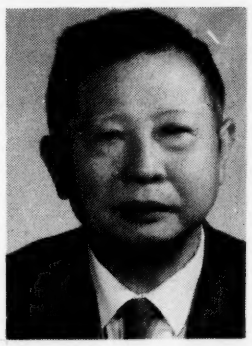
Jeffrey D. Ullman is a Professor and the Chairman of the Computer Science Department at Stanford University, where he has taught since 1979. Previously, he taught at Princeton for ten years and worked at Bell Laboratories for three years. He is a member of the US National Academy of Engineering, and has served on a number of advisory panels, including NFS panels for computer science, the CS Graduate Record Examination Committee and the ACM Council. He held an Einstein Fellowship from the Israeli Academy of Sciences in 1984 and a Guggenheim Fellowship in 1989. His current research interests include database theory, deductive databases and logic programming.



Jan van Leeuwen (born in 1946) is a Full Professor and the Chairman of the Department of Computer Science at Utrecht University. Between 1989 and 1992 he was the coordinator of the ESPRIT Basic Research Action No. 3075 for research in algorithms and complexity (project "ALCOM") by twelve leading research groups in Western Europe. Since 1992 he is coordinator of the Cooperative Action IC 1000 for research on algorithms for future technologies (project "ALTEC") by seven leading research groups in Western and Eastern Europe, as well as co-leader of the Dutch NWO/NFI project on algorithmic aspects of parallel and distributed systems (project "ALADDIN"). He was the Managing Editor of the two-volume *Handbook of Computer Science.* His reseach interests in computer science range from theoretical research (e.g. in data structures, graph algorithms, distributed algorithms and complexity theory) to more applied fields in computing amenable to theoretical modeling (e.g. in software engineering).

Jack H. van Lint[a] studied mathematics and physics at the University of Utrecht, where he obtained his Ph.D. in 1957 (with a thesis on number theory). Since 1959 he has been Professor of mathematics at the Eindhoven University of Technology (The Netherlands), where he is currently the Rector Magnificus. In 1972 he was appointed member of the Royal Netherlands Academy of Sciences (KNAW). During several sabbaticals in the USA he was member of Technical Staff at Bell Laboratories (three times), Visiting Professor (two times) and Fairchild Distinguished Scholar at the California Institute of Technology. Professor Van Lint is on the editorial board of several international journals. His scientific interests include: coding theory, discrete mathematics, number theory, mathematical games and mathematics education.

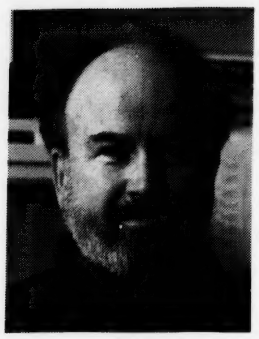
[a]Photo: Technische Universiteit Eindhoven, Stafgroep Reproductie en Fotografie.



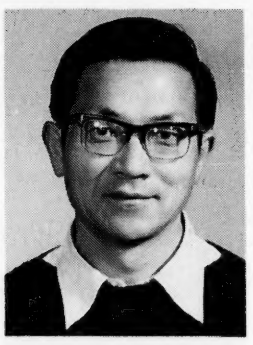
Xu Jiafu is a Professor and the Director of the Institute of Computer Software at Nanjing University. He is also the Director of the State Key Laboratory of Novel Software Technology of China and Vice-President of the Chinese Computer Federation. Professor Xu was born in Nanjing in 1924. He received his B.S. in mathematics from the National Central University in 1948. He has been involved in research on computer software since 1957, when he was a visiting scholar in Moscow State University. In 1964, he and his group developed the first Algol compiler in China. In 1978–80, he designed and implemented the systems programming language XCY. In 1981–84, the group led by him developed a data-driven reduction machine, in 1986 a parallel inference machine was completed, and since then several experimental software automation systems were developed. He was awarded 14 national and provincial awards, and published over 100 papers and two

books. Now, his research interests include computer languages, software automation, novel programming, natural-language understanding and processing, analogy theory and category theory.

Frances Yao is now Principal Scientist and Manager of the Theoretical Computer Science area at Xerox Palo Alto Research Center. She received her Ph.D. in mathematics from MIT in 1973, and taught at several universities, including Stanford (1976–79). Her research interests span theoretical computer science, with emphasis on computational geometry.



Paul Young, Professor of computer science at the University of Washington in Seattle, received his Ph.D. in mathematics from MIT in 1963. He is author or co-author of some thirty papers in theoretical computer science and recursive function theory as well as co-author of a graduate textbook on the general theory of algorithms. His research interests are in computational complexity and connections with mathematical logic.



Zhou Chaochen was born in 1937. He graduated from Peking University in 1958, and finished his postgraduate study in Academica Sinica in 1967. He is now Professor of computer science at the Institute of Software of the Academia Sinica in Peking. His main research interests are: specifications, semantics and verification of programs, concurrency and formal aspects of real-time systems.

Lectures on Homotopy Theory

by **R.A. Piccinini**

North-Holland Mathematics Studies Volume 171
1992 xii + 294 pages
Price: US $ 92.50 / Dfl. 180.00
ISBN 0-444-89238-9

The central idea of the lecture course which gave birth to this book was to define the homotopy groups of a space and then give all the machinery needed to prove in detail that the n^{th} homotopy group of the sphere S^n, for n greater than or equal to 1 is isomorphic to the group of the integers, that the lower homotopy groups of S^n are trivial and that the third homotopy group of S^2 is also isomorphic to the group of the integers. All this was achieved by discussing H-spaces and CoH-spaces, fibrations and cofibrations (rather thoroughly), simplicial structures and the homotopy groups of maps.
Later, the book was expanded to introduce CW-complexes and their homotopy groups, to construct a special class of CW-complexes (the Eilenberg-Mac Lane spaces) and to include a chapter devoted to the study of the action of the fundamental group on the higher homotopy groups and the study of fibrations in the context of a category in which the fibres are forced to live; the final material of that chapter is a comparison of various kinds of universal fibrations.
Completing the book are two appendices on compactly generated spaces and the theory of colimits. The book does not require any prior knowledge of Algebraic Topology and only rudimentary concepts of Category Theory are necessary; however, the student is supposed to be well at ease with the main general theorems of Topology and have a reasonable mathematical maturity.

Contents: 1. Homotopy Groups. 1.1 Function Spaces. 1.2 H-Spaces and CoH-Spaces. 1.3 Homotopy Groups. 2. Fibrations and Cofibrations. 2.1 Pullbacks and Pushouts. 2.2 Fibrations. 2.3 Cofibrations. 2.4 Applications of the Mapping Cylinder. 3. Exact Homotopy Sequences. 3.1 Exact Sequence of a Map: Covariant Case. 3.2 Exact Sequence of a Map: Contravariant Case. 4. Simplicial Complexes. 4.1 Simplicial Complexes. 4.2 Simplicial Approximation Theorem. 4.3 Polyhedra. 4.4 Fibrations and Polyhedra. 5. Relative Homotopy Groups. 5.1 Homotopy Groups of Maps. 5.2 Quasifibrations. 5.3 Some Homotopy Groups of spheres. 6. Homotopy Theory of CW-complexes. 6.1 CW-complexes. 6.2 Homotopy theory of CW-complexes. 6.3 Eilenberg-Mac Lane spaces. 7. Fibrations revisited. 7.1 Sections of fibrations. 7.2 *F*-fibrations. 7.3 Universal *F*-fibrations. Appendix: Colimits. Compactly generated spaces. Index.

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Programming Environments for High-Level Scientific Problem Solving

Proceedings of the IFIP TC2/WG2.5 Working Conference, Karlsruhe, Germany, 23-27 September 1991

edited by **P.W. Gaffney** *and* **E.N. Houstis**

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[1] E. Börger, *Computability, Complexity, Logic* (North-Holland, Amsterdam, 1989).

[2] D.E. Knuth, Theory and practice, *Theoret. Comput. Sci.* **90** (1991) 1–15.

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[5] A. Rajasekar, Semantics for logic programs, Ph.D. Thesis, Department of Computer Science, University of Maryland, 1989.

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THEORETICAL COMPUTER SCIENCE

CUMULATIVE INDEX VOLUMES 1-100, JUNE 1992

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